

# COGS 101A: Sensation and Perception

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Department of Cognitive Science

UCSD

Lecture 2:

The Eye pp37-43, 545-558

# Course Information

- Class web page: <http://cogsci.ucsd.edu/~desa/101a/index.html>
- Professor: Virginia de Sa
  - ★ I'm usually in Chemistry Research Building (CRB) 214 (also office in CSB 164)
  - ★ Office Hours: Monday 5pm CRB 214
  - ★ email: desa at ucscd
  - ★ Research: Perception and Learning in Humans and Machines

# At your Assistance

TAS:

- Jelena Jovanovic OH: Wed
- Katherine DeLong OH: Thurs

IAS:

- Jennifer Becker OH: Fri 9-10 or 10-11 CSB 114
- Lydia Wood OH: Mon 12-1pm CSB 114

# Course Goals

- To appreciate the difficulty of sensory perception
- To learn about sensory perception at several levels of analysis
- To see similarities across the sensory modalities
- To become more attuned to multi-sensory interactions

# Grading Information

- 25% each for 2 midterms
- 32% comprehensive final
- 3% each for 6 lab reports - due at the end of the lab
- Bonus for participating in a psych or cogsci experiment AND writing a paragraph description of the study

You are responsible for knowing the lecture material and the assigned readings. Read the readings before class and ask questions in class.

# Academic Dishonesty

The University policy is linked off the course web page.

You will all have to sign a form in section

For this class:

- Labs are done in small groups but writeups must be in your own words
- There is no collaboration on midterms and final exam

fhedLast Class

We got a feel for different techniques to study the visual system and learnt a little bit about the ventral visual pathway.

We saw evidence of top-down processing and learning in vision

We learned the classical Psychophysical techniques

# The Visual System is not a fixed feed-forward system

It is influenced by

- prior experience
- surrounding visual scene (and not just immediate)
- recent prior exposure
- learned familiarity with special objects
- concurrent input in other sensory modalities (where the relationship has been well learned)

# How do we study Perceptual Systems?

- Physiology
  - ★ Single Cell Electrophysiology – what do neurons respond to?
  - ★ Optical Imaging – what are groups of neurons responding to?
  - ★ microstimulation – how does the animal respond when we stimulate?
- Psychophysics
  - ★ observe and analyze visual illusions
  - ★ observe and analyze people with brain damage
  - ★ threshold detection



## Difference Threshold (DL Differenze Limin)

Now commonly called **Just Noticeable Difference (JND)** : smallest detectable increase or decrease in stimulus energy

**Weber's Law:**  $\frac{DL}{S} = K$

true for most sensations as long as significantly above threshold

Why does it not hold at threshold?

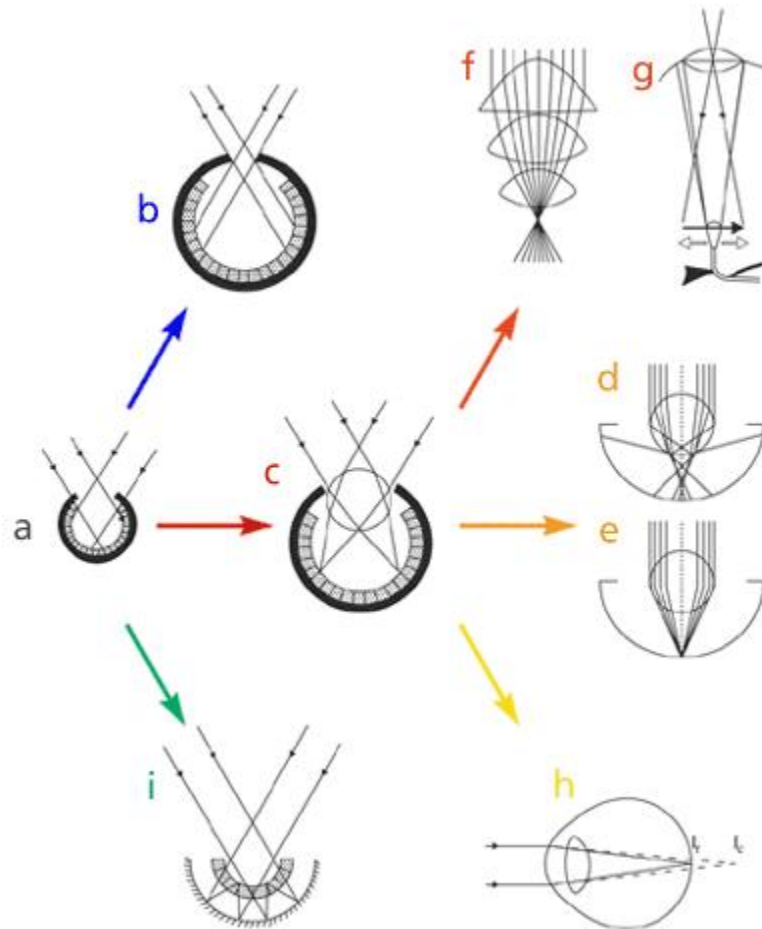
# This Class

The Eye

# Evolution of the Eye

PBS movie [http://www.pbs.org/wgbh/evolution/library/01/1/l\\_011\\_01.html](http://www.pbs.org/wgbh/evolution/library/01/1/l_011_01.html)

# Evolution of the Eye

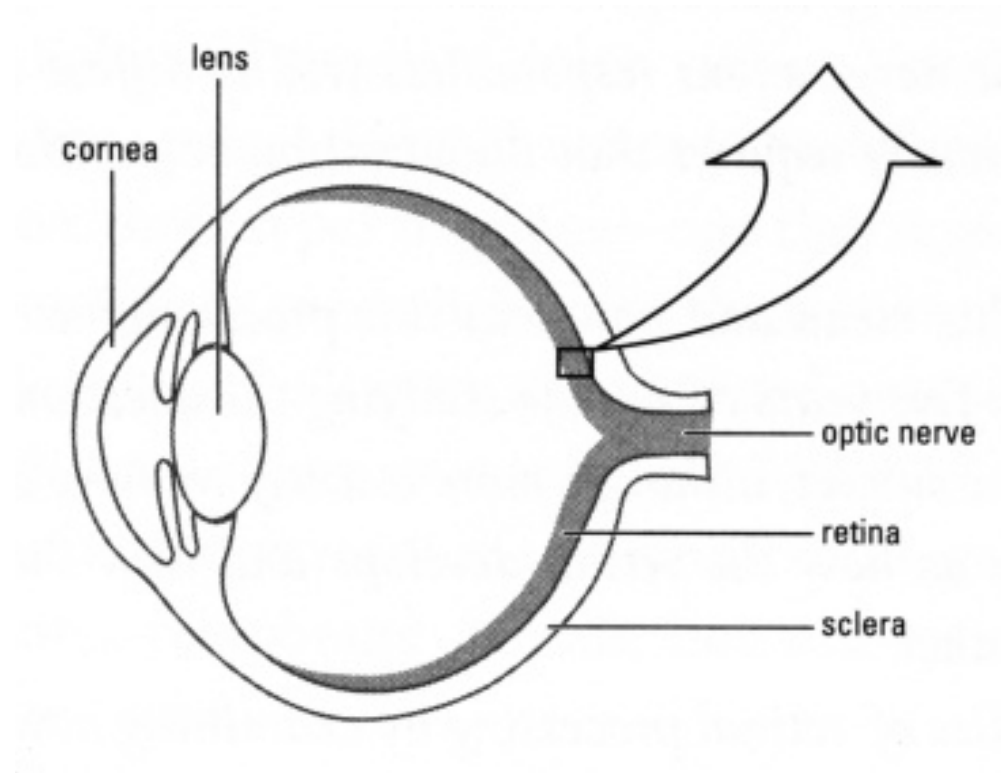


[http://www.karger.com/gazette/64/fernald/art\\_1\\_5.htm](http://www.karger.com/gazette/64/fernald/art_1_5.htm)

light sensitive cells evolved to pit eyes

to get better focus have to either reduce the opening or introduce a lens

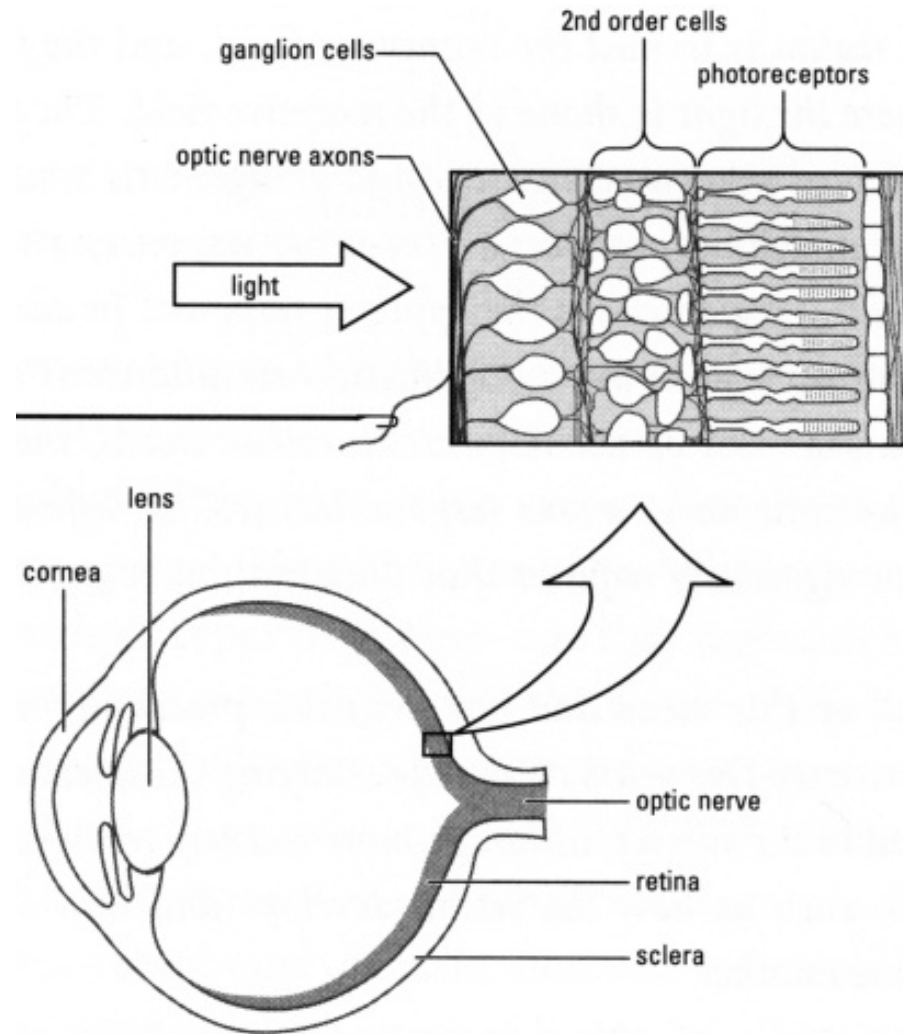
# The Eye



cornea – modified (transparent) forward surface of the sclera, provides 70-80% of the eye's focusing power

lens - gives the adjustable focusing power

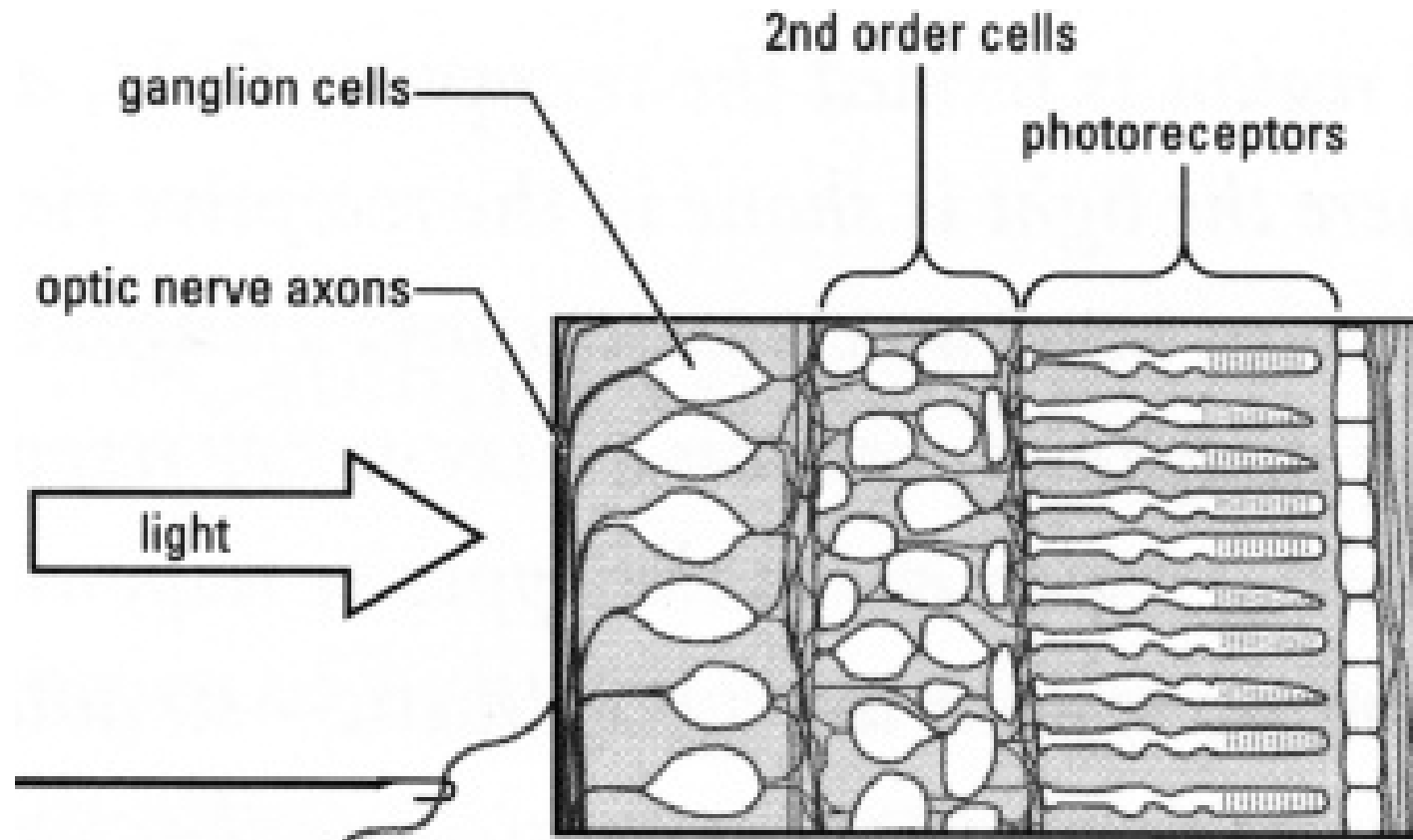
# The Eye



retina -visual receptors and other neurons, covers rear of the eye

optic nerve - axons of retinal ganglion cells – only connection to the brain

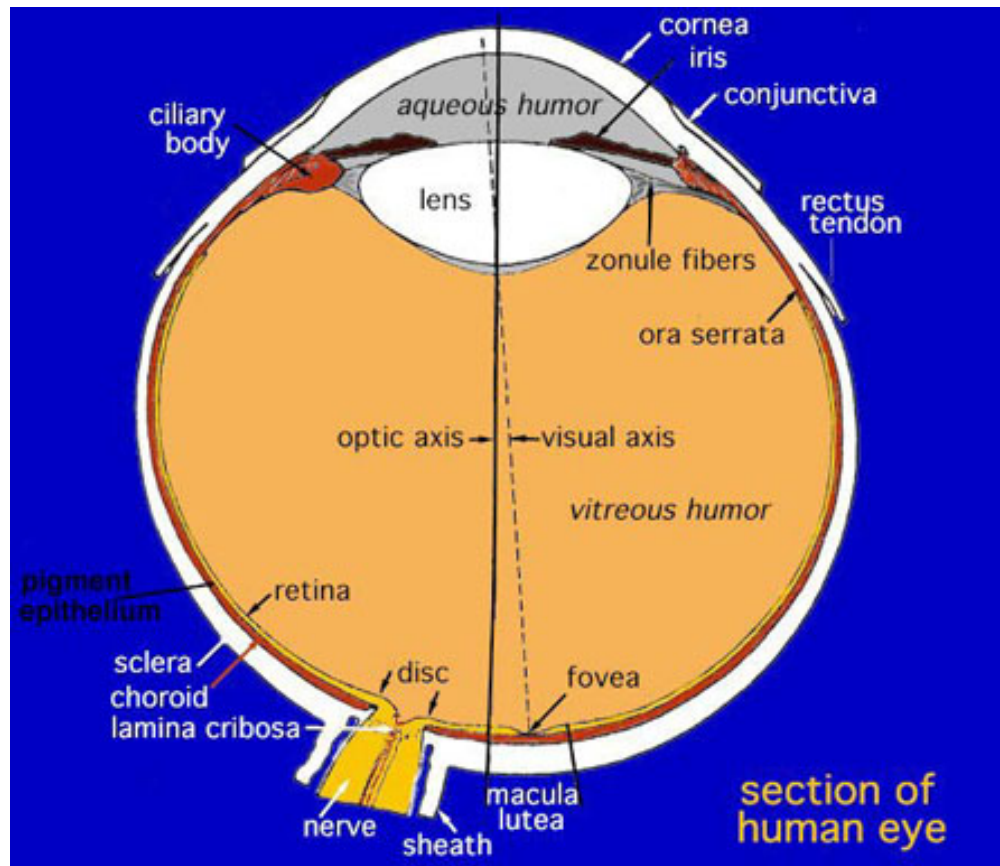
# The Eye



Photoreceptors transduce the light to electrical signals

**Transduction** : the transformation of one form of energy to another the photoreceptors transduce light to electrical signals (voltage changes)

# The Eye



[http://www.phys.ufl.edu/~avery/course/3400/vision/eye\\_human2.jpg](http://www.phys.ufl.edu/~avery/course/3400/vision/eye_human2.jpg)

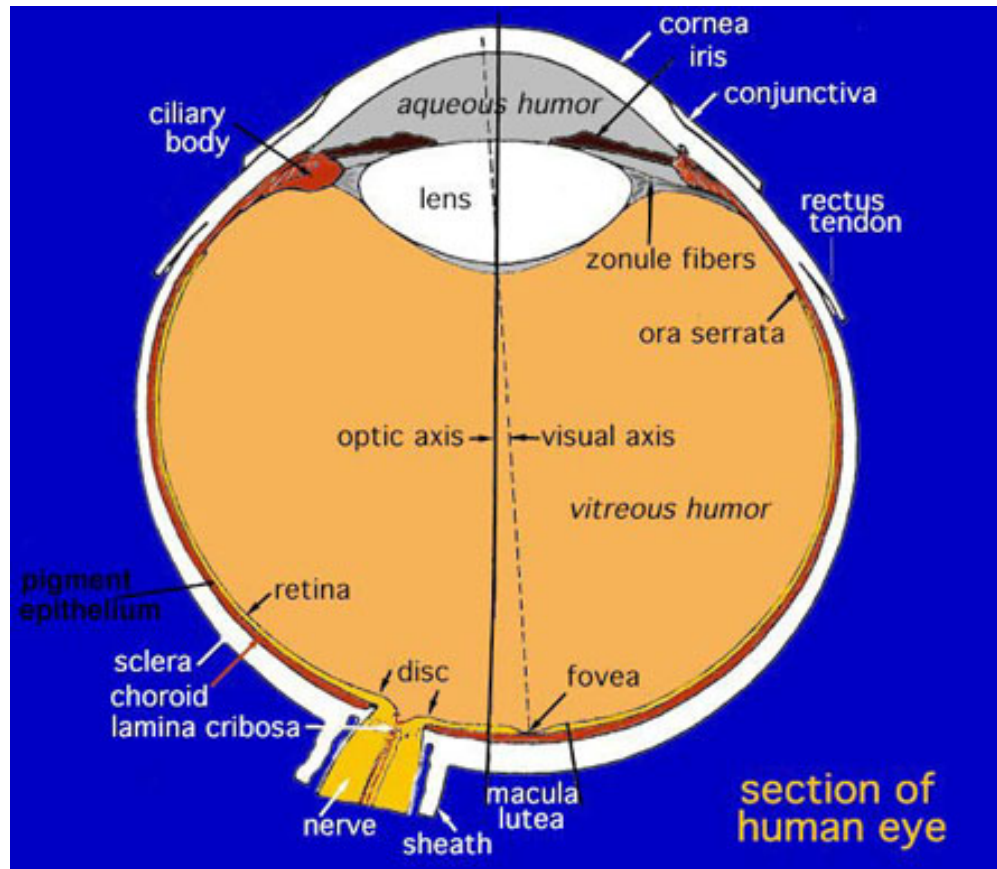
aqueous humor- transparent fluid between lens and cornea - helps keep cornea round

vitreous humor-jelly like substance that fills the eye



pigment epithelium - layer behind retina – helps feed and recycle receptors

# The Eye



[http://www.phys.ufl.edu/~avery/course/3400/vision/eye\\_human2.jpg](http://www.phys.ufl.edu/~avery/course/3400/vision/eye_human2.jpg)

Iris - colored radial muscles, constrict and dilate the pupil

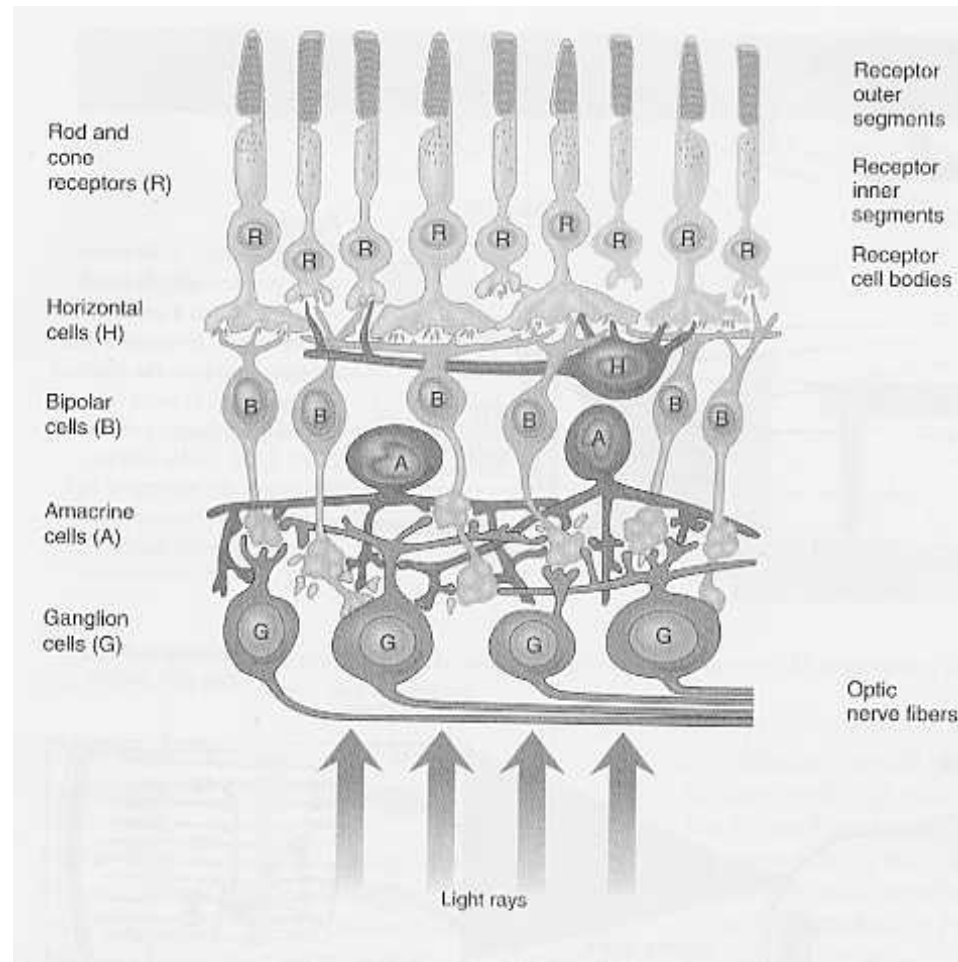
Pupil - aperture in iris

Ciliary Muscles - change shape of the lens

# Movie

movie about the eye

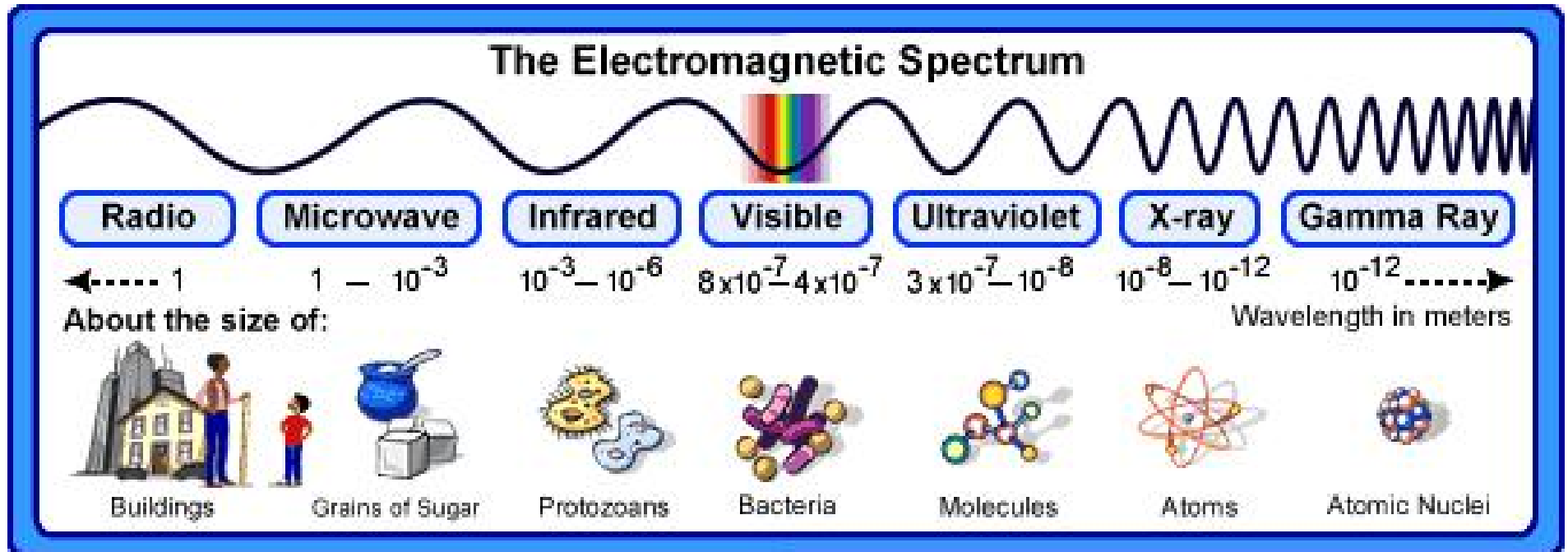
# The Retina



<http://www.owl.net.rice.edu/~psyc351/imagelist.htm>

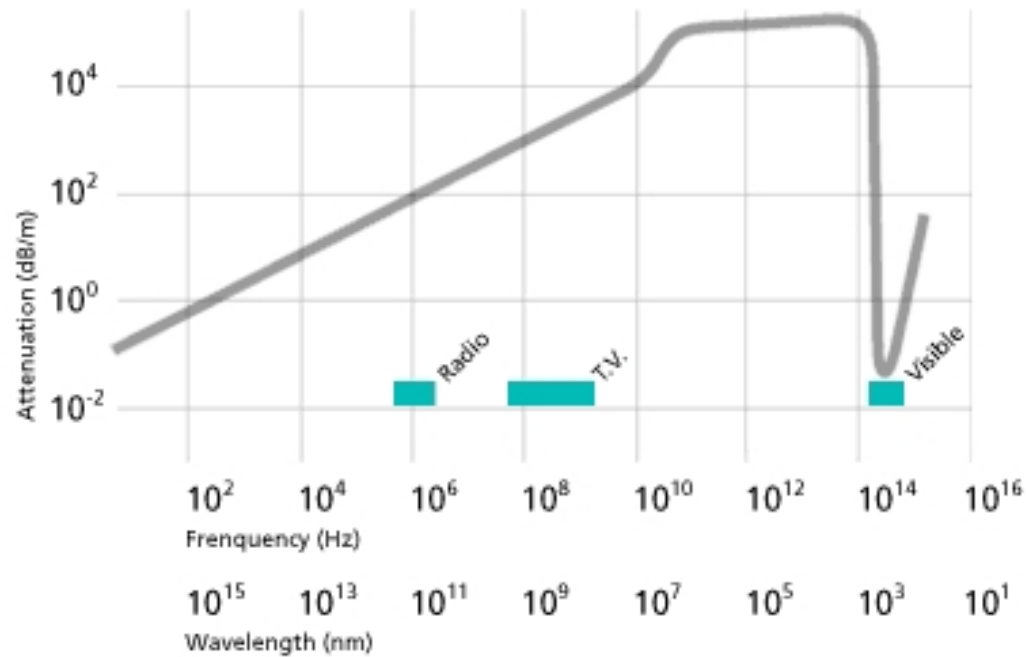
Note the photoreceptors are farthest from the light. But the other neurons are transparent so it's not a big deal.

# We only detect “visible” electromagnetic radiation



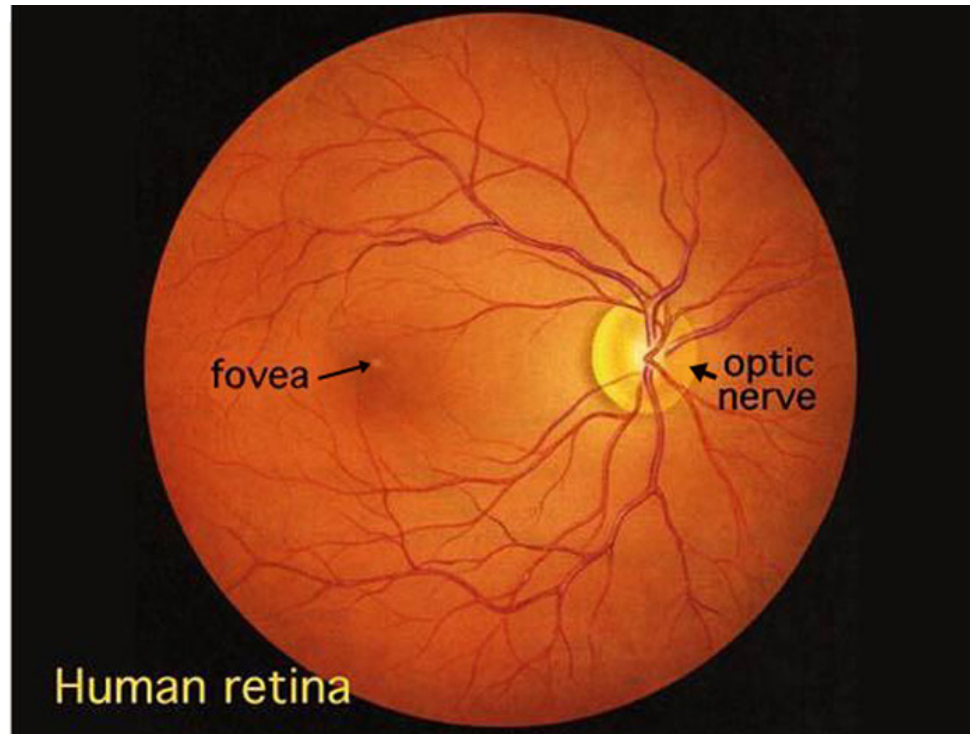
<http://skyserver.sdss.org/dr1/en/proj/advanced/color/whatis.asp>

# Why do we only detect this small segment?



[http://www.karger.com/gazette/64/fernald/art\\_1\\_5.htm](http://www.karger.com/gazette/64/fernald/art_1_5.htm)

# Human retina



*Fig. 1. Human retina as seen through an ophthalmoscope.*

<http://webvision.med.utah.edu/imageswv/huretina.jpeg>

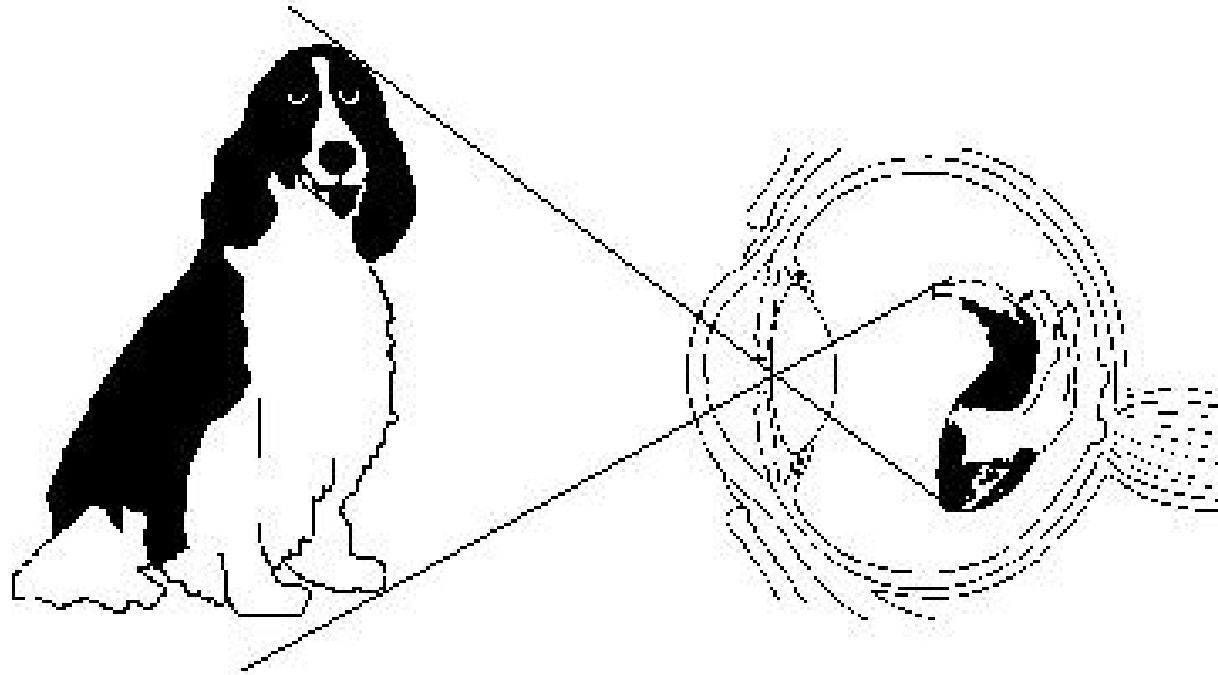
# A great set of flash lecture notes

link to notes

<http://www.med.uwo.ca/physiology/courses/sensesweb> by Tutis Vilis, University of Western Ontario, Canada



## The image projected on the retina is inverted



[www.yorku.ca/ eye/invert.htm](http://www.yorku.ca/eye/invert.htm)

Why doesn't this matter?

# Focussing the Lens

The Lens is naturally round

Zonules of Zinn are fibers that encase the lens and flatten it

from Chris Johnson “Think balloon in pantyhose”

When the ciliary muscles are contracted, they pull the zonule fibers back and lens goes back to rounder

Who is Zinn

**Accommodation:** increasing focussing power to see closer objects

At rest in people with normal vision light rays from a distant source are focused on the retina

# Definitions

**Near point** - nearest distance that you can bring in to focus (due to a limit in how round the lens can get)

**Far point** - farthest distance that you can bring in to focus

20:20 - **Normal vision** see at 20 feet as well as a normal eye does at 20 feet

20:40 - see as well at 20 feet as a normal sees at 40 feet (worse)

20:10 - see as well at 20 feet as a normal does at 10 feet (better)

# Trouble with Focussing

- Hyperopia - “farsightedness” - near point is too far away (eye too short or lens/cornea don't bend light enough)
- Myopia - “nearsightedness” - far point is close (eye too long or lens/cornea bend light too much)
- Presbyopia - “Old Eye” - near point moves farther away (lens hardens and ciliary muscles get weaker with age)
- Astigmatism - misshaped cornea usually vertical or horizontal lines are clear but not both

# Focussing Problems

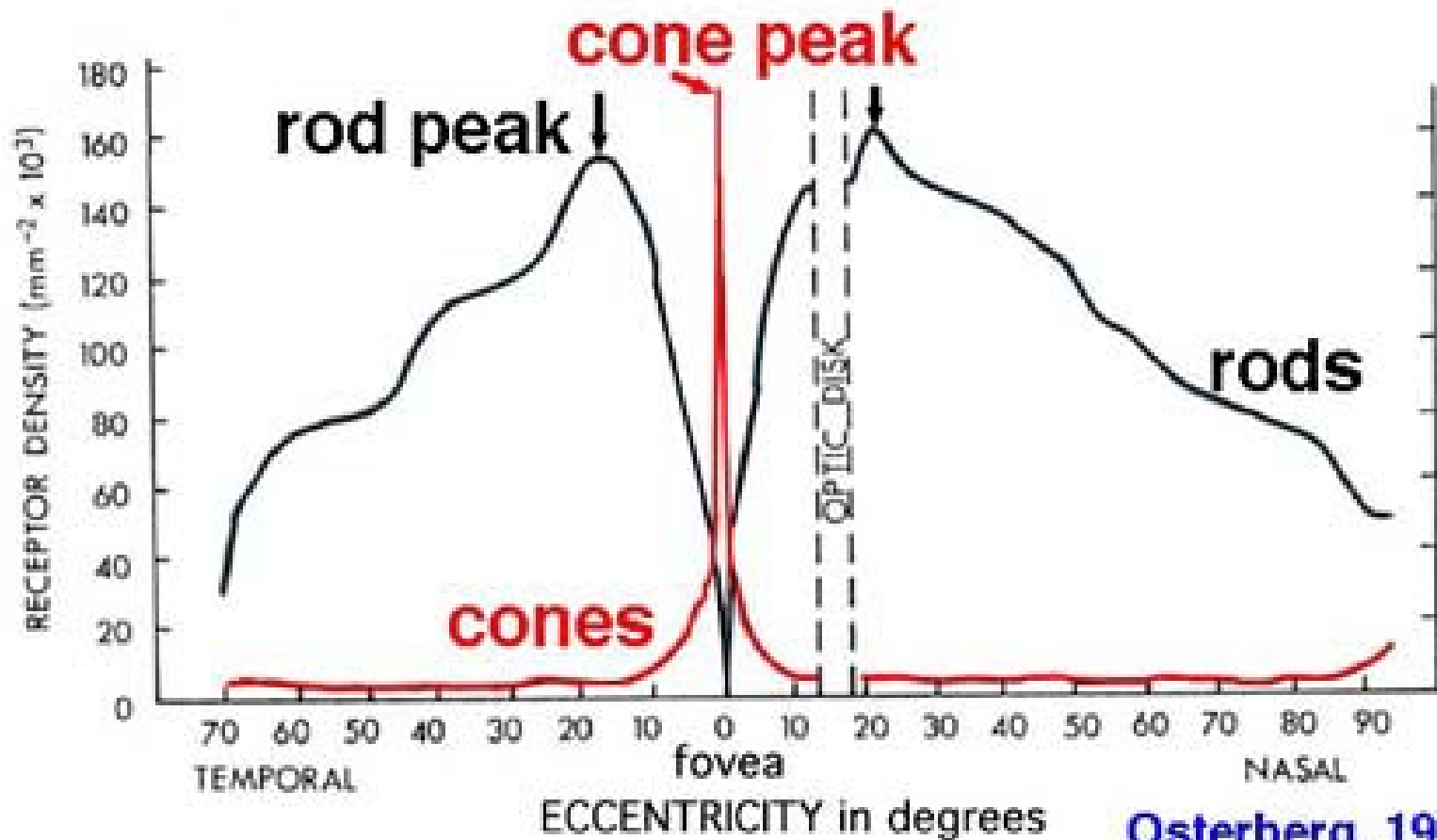
A little applet

[http://webphysics.davidson.edu/physlet\\_resources/dav\\_optics/Examples/eye\\_demo.htm](http://webphysics.davidson.edu/physlet_resources/dav_optics/Examples/eye_demo.htm)

## For the Labs you will need to know

Photoreceptors come in two different kinds **Rods** and **Cones**. There are 3 cone subtypes. Differential activity in cones allows us to see different colors

# Distribution of Rods and Cones in the Retina



[http://www.phys.ufl.edu/~avery/course/3400/vision/rod\\_cone\\_distribution2.jpg](http://www.phys.ufl.edu/~avery/course/3400/vision/rod_cone_distribution2.jpg)

Note – There are no photoreceptors where the optic nerve leaves the eye (optic disk) “blind spot”. The blind spot is more nasal (towards the nose) than the fovea.

## Next Class

We will learn more about the Retina